

Compact Magnet-less Circulators for ACE and Other NASA Missions

Completed Technology Project (2014 - 2017)



Project Introduction

The NASA Aerosol/Cloud/Ecosystems (ACE) Mission, recommended by the National Research Council's Earth Science Decadal Survey, will support the development of advanced instruments to measure cloud droplets, ice crystals, rain and snow, and other hydrometeor types and to understand how their dynamics are influenced by the presence of aerosols. These influences impact the Earth's ecosystems and the ocean's storage of carbon dioxide. ACE and other NASA missions require innovative component-level technology that: (i) reduces risk, cost, size, volume, mass, and development time of Earth observing instruments; and (ii) enables new data acquisition for enhanced observation measurements. In the proposed effort Metamagnetics Inc. in collaboration with a NASA prime contractor addresses these requirements through the development of an ultra-lightweight, compact, cost-effective, high-performance, magnet-less circulator for use in sensors and communications phased arrays. This technology has important applications in ACE as well as other NASA missions. A circulator provides duplex capability in a phased array transmit/receive module and isolates amplifiers from unwanted reflections. Conventional ferrite circulators occupy a disproportionately large volume in the front-end the T/R module because of the large permanent magnet required to provide the necessary magnetic bias field. The main innovation of the proposed technology consists in Metamagnetics' proprietary self-biased circulator substrate that does not require external biasing and allows >90% reduction in volume and weight of the device. Our self-biased circulator eliminates the permanent magnet by utilizing a crystallographically textured material that possesses high remnant magnetization and low microwave losses while improving reliability and supply chain security. In a previous Phase I NASA SBIR contract Metamagnetics developed a proof of concept prototype of the proposed circulator demonstrating TRL 4. Over the 36-month period of performance of the proposed effort we will develop, fabricate, and test self-biased circulators specifically designed to meet performance requirements set for the NASA Aerosol/Cloud/Ecosystems (ACE) Mission and will deliver multiple units to NASA prime contractor that will perform system integration and system testing. At the end of the proposed effort we predict to reach TRL 6. Our Team of highly accomplished scientists and engineers combines Metamagnetics, Inc. expertise in advanced ferrite-based development for military security, surveillance and communication systems, and NASA prime contractor system engineering know-how in microwave radar systems for ground-based, space, and airborne platforms. NASA prime contractor is actively involved in the ACE program and in view of Metamagnetics' circulator technology high potential has already invested \$100,000 in in-kind funds to evaluate Metamagnetics' self-biased materials and circulator components.



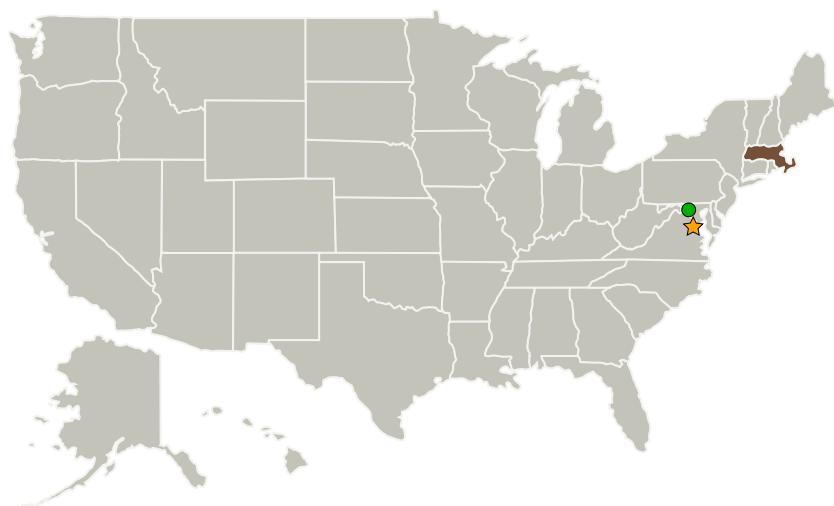
ALHAT - ETD Autonomous
Landing & Hazard Avoidance
Tech Earth Science Technology
Office

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ NASA Headquarters(HQ)	Lead Organization	NASA Center	Washington, District of Columbia
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
Metamagnetics, Inc.	Supporting Organization	Industry Veteran-Owned Small Business (VOSB)	Canton, Massachusetts

Primary U.S. Work Locations

Massachusetts

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

NASA Headquarters (HQ)

Responsible Program:

Advanced Component Technology Program

Project Management

Program Director:

Pamela S Millar

Program Manager:

Amber E Emory

Principal Investigator:

Anton Geiler

Co-Investigator:

Elaine Trudell



Images

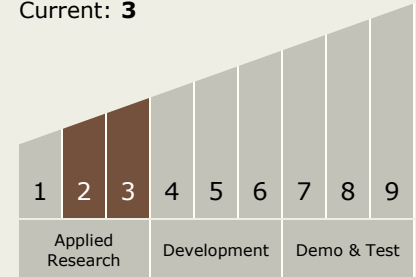


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(<https://techport.nasa.gov/image/5094>)

Technology Maturity (TRL)

Start: 2
Current: 3



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination

Earth